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ABSTRACT

This essay reports on the shortage of doctorates in mathematics education. The history of the production of doctorates in mathematics education is discussed as are the factors influencing supply and demand. Statistics are presented that indicate that almost 80% of faculty in mathematics education will be eligible for retirement in the years 2000-2010. (MM)

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Doctorates in Mathematics Education—An Acute Shortage

Robert E. Reys

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Golden lion tamarins, Siberian tigers, and doctorates in mathematics education share some common properties. While none are extinct, each is in short supply and in high demand. In October 1999 a National Conference on Doctoral Programs in Mathematics Education sponsored by the National Science Foundation provided a forum to discuss issues related to doctoral programs in mathematics education. The presentations and discussions focused on tracing the historical evolution of doctoral programs in mathematics education; core areas of preparation, such as mathematics, mathematics education, and research; and patterns of the production of doctorates in mathematics education since 1980 [3].

The expansion of job opportunities for people with doctorates in mathematics education continues to increase. For example, an increasing number of mathematics departments are actively recruiting doctorates in mathematics education not only to teach but to conduct research in areas related to mathematics education. In addition to the increasing demand within mathematics departments, other job opportunities in schools/departments of education, school districts, governmental positions, publishers, and testing companies have increased. Despite the rosy job market, the number of new doctorates in mathematics education over the last twenty years has remained relatively stable, with an annual median of 70. These conditions have produced a current shortage that is likely to be exacerbated by the fact that a large percentage of mathematics education faculty are eligible for retirement during the next few years.

This article highlights the record of production of doctorates in mathematics education in the United States and discusses some of the factors contributing to the current shortage of educators with doctorates in mathematics education.

Production of Doctorates in Mathematics Education

The first doctoral programs in mathematics education were established at Teachers College, Columbia University, and at the University of Chicago in the early part of the twentieth century [1]. These doctoral programs in mathematics education were influenced by and modeled after the doctoral programs in mathematics at Columbia University and the University of Chicago that were ongoing and well respected. These mathematics education doctoral programs evolved over time and paved the way for the development of other doctoral programs that have taken various forms at different institutions.

For the years 1980 to 1998, the National Research Council (NRC) reports that 1,386 doctoral degrees with a major field of mathematics education were awarded by 126 different institutions in the United States [7]. The focus of these doctoral

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programs varies greatly. While one program may consist of a large component of mathematical content together with selected graduate courses in education, another program may reflect an even distribution of courses in mathematics and mathematics education. Some programs include a mentoring model involving graduate students in research projects, thereby providing a research practicum or internship, while other programs provide research preparation for the dissertation via coursework only. One program may graduate a cadre of students annually with doctorates in mathematics education, while other programs may produce one graduate every few years. Each program is autonomous and often oblivious to other mathematics education programs around the country. All of these factors contribute to a very diverse preparation for people holding doctorates in mathematics education.

The National Research Council provides data on conferred research doctorates from almost 400 colleges and universities in the United States. Data are collected through surveys and distributed via the graduate deans of each institution to students who are completing requirements for their doctorate. These reports summarize research and applied-research doctorates in all fields. While not all parts of the survey are completed by every graduate, all doctoral recipients provide their gender, major field, and graduation year [4], [5], [6].

One item on the NRC survey asks graduates to identify the field of specialization for their doctorate from a given list of codes. The 1,386 graduates who identified "Mathematics Education" as their major area were considered to have earned a doctorate in mathematics education [7]. It can be argued that self-reporting provides reliable and valid data (who better to identify her/his major field than the person receiving the doctorate?). However, the organizational structure of an institution may lead some mathematics education doctorates to code their area of emphasis in other ways—such as "Curriculum and Instruction", "Elementary Education", or "Educational Leadership" thereby excluding them from this survey. Thus the number of "Mathematics Education" doctorates

Institutions awarding at least 26 doctorates in mathematics education during 1980–1998

(27)	Boston University	(112)	Teachers College-Columbia University
(38)	Florida State University	(33)	Temple University
(52)	Georgia State University	(89)	University of Georgia
(31)	Indiana University-Bloomington	(31)	University of Iowa
(46)	New York University	(37)	University of Maryland
(59)	Ohio State University	(79)	University of Texas-Austin
(32)	Rutgers University	(29)	University of Wisconsin-Madison
(29)	State University of New York-Buffalo		

Institutions awarding at least 8 but no more than 25 doctorates in mathematics education during 1980–1998

(25)	American University	(8)	University of Delaware
(11)	Auburn University	(9)	University of Florida
(11)	Cornell University	(11)	University of Houston
(12)	Illinois State University	(15)	University of Illinois
(16)	Michigan State University	(17)	University of Massachusetts-Amherst
(23)	North Carolina State University	(9)	University of Massachusetts-Lowell
(8)	Northwestern University	(10)	University of Michigan
(8)	Ohio University	(18)	University of Minnesota
(8)	Oklahoma State University	(18)	University of Missouri-Columbia
(15)	Oregon State University	(11)	University of Northern Colorado
(14)	Peabody College-Vanderbilt	(23)	University of Oklahoma
(9)	Pennsylvania State University	(25)	University of Pittsburgh
(12)	Purdue University	(13)	University of South Carolina
(8)	Southern Illinois University	(14)	University of South Florida
(9)	Stanford University	(15)	University of Tennessee-Knoxville
(13)	Syracuse University	(11)	University of Virginia
(21)	University of California-Berkeley		

Note. Data for this table came from a special request to the NRC.

Table 1. Institutions reported by total number of doctorates in mathematics education awarded from 1980–1998 as reported by the National Research Council.

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as reported by the NRS survey represents a conservative estimate.

Most of the doctoral programs in mathematics education are small, as is evidenced by the fact that about 40% of the institutions have awarded a total of two or fewer doctorates during the last two decades. Table 1 shows institutions that have awarded a total of at least eight doctorates to people identifying mathematics education as their major area. The fifteen institutions in Group 1 produced slightly more than half (52%), and the institutions in Group 2 produced about one-third of all of the doctorates in mathematics education from 1980 to 1998. Although Table 1 does not reflect new or emerging doctoral programs in mathematics education, such as Montclair State University and Western Michigan University, it does identify institutions that have produced the greatest number of doctorates in mathematics education over the last two decades. Furthermore, it also shows that less than fifty institutions produced the overwhelming majority (about 85%) of the doctorates in mathematics education.

According to the most recent NRC data, there were 100 doctorates in mathematics education (35 males and 65 females) awarded from July 1, 1995, to June 30, 1996; 88 (37 males and 51 females) from July 1, 1996, to June 30, 1997; and 115 (37 males and 78 females) from July 1, 1997, to June 30, 1998 [4], [5], [6]. Since 1980 the number of doctorates awarded in mathematics education has ranged from a low of 50 in 1982 to a high of 115 in 1998, with a yearly average of about 70. For comparison, there were 1,122 doctorates in mathematics (891 males and 231 females) in 1995–96; 1,112 (845 males and 267 females) in 1996–97; and 1,177 (880 males and 297 females) in 1997–98 [4], [5], [6]. It is interesting to note that the total annual number of doctorates in mathematics education is about the same as the number of doctorates in mathematics with Analysis/Functional Analysis as their major field. For example, there were 100 (85 males and 15 females) awarded a doctorate in Analysis/Functional Analysis in 1995–96; 103 (90 males and 13 females) in 1996–97; and 130 (105 males and 25 females) in 1997–98 [4], [5], [6].

Factors Influencing Supply and Demand

The role of mathematics educators has evolved and continues to evolve over time. Historically, mathematics educators' role tended to be as faculty in (1) mathematics departments whose primary function was to teach mathematics and/or work with mathematics teacher education majors, and (2) colleges of education with the expectation of research related to mathematics education. A newly emerging job placement for doctorates in mathematics education is taking place within mathematics departments actively seeking mathematics educators not only to teach mathematics and mathematics education classes but also to engage and lead research in the teaching and learning of undergraduate mathematics. This trend confirms a growing acceptance and expectation of scholarship based on research in mathematics education for faculty in mathematics departments [8]. In addition to careers in higher education, there are increasing opportunities for people with doctorates in mathematics education in large school districts (including both classroom teachers and district coordinators) as well as in leadership roles in city, regional, and state departments of education.

These diverse and growing employment opportunities for mathematics educators exceed the current supply and have led to the need for more people with doctorates in mathematics education. An informal collection of job listings and announcements for positions in the *Chronicle of Higher Education* and various listservers showed more than 300 positions in mathematics education during each of the last two years. The number of openings in mathematics education far exceeded the number of people earning doctorates in mathematics education.

This imbalance between supply and demand was personally experienced. Recent job searches at the University of Missouri-Columbia (spring 2000) vividly illustrate the challenges of recruitment. Announcements of multiple positions in the Department of Mathematics (eight, including several postdoctorate positions) and Department of Curriculum and Instruction (three tenure-track mathematics education positions) resulted in over 400 applications for the mathematics positions and fewer than twenty applications for the mathematics education positions.

The shortage has been exacerbated by a number of factors, including: new areas of specialty in mathematics education due to the rapid and dramatic changes in technology to support the learning and teaching of mathematics; a decrease in the number of students studying advanced mathematics in higher education; a shortage of certified mathematics teachers in middle, junior, and senior high schools; and increasing requirements for studying more mathematics at the secondary and postsecondary levels within a number of different fields. In addition, a recent survey of mathematics education faculty in 48 doctoral-granting institutions indicated that over half (115 of the 224, or 51%) of the mathematics education faculty are eligible for retirement within 0–2 years, about 15% are eligible within 3–5 years, and 12% are eligible within 6–10 years (see Figure 1). Thus, almost 80% of current mathematics education faculty in these institutions are eligible for retirement within the next ten years [6]. The extent to which these data can be generalized is unknown, but it seems likely that this changing of the guard will create

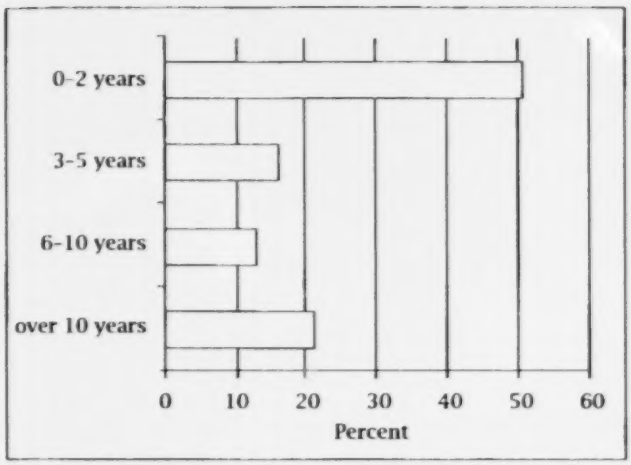

Figure 1. Percentage of current faculty in mathematics education by years until eligible for retirement.

additional demands for doctorates in mathematics education.

A Call for Help

While a simple and unique solution to address the growing shortage of mathematics education doctorates does not appear to exist, there are multiple approaches to increasing the supply of doctorates in mathematics education. Here are three action steps that would help address the situation.

1. Develop a procedure (maybe similar to the Annual AMS Survey) that provides a valid measure of the number of doctorates in mathematics education that are awarded and the location of these programs. The techniques used by the NRC provide at best a rough measure of the annual production of doctorates in mathematics education, and more accurate information is needed.
2. Encourage the National Science Foundation (NSF) and the Department of Education to support the development of mathematics education doctoral programs. This might take a variety of forms, including scholarships or year-long institutes to support recruiting efforts and the initiation of Request for Proposals (RFPs) to departments of mathematics and colleges of education to work collaboratively in recruiting more doctoral students in mathematics education. It might also provide opportunities for mathematicians interested in pursuing a career in mathematics education to receive postdoctoral support during their professional development.
3. Encourage the leadership of professional organizations (particularly the AMS, MAA, and NCTM) to collaborate by publicizing the need for increased doctorates in mathematics education and by working together toward solutions. It is possible that recognition of the opportunities available for mathematics educators may encourage more mathematicians to consider mathematics education as a career option. The collective influence of these professional organizations would be a powerful force in encouraging more people to seek doctorates in mathematics education, as well as stimulating initiatives by private foundations as well as federal agencies, such as the NSF and Department of Education.

Implementation of each of these action steps will help focus attention, energy, and resources on a critical need. Only significant collaborative efforts will help institutions attract well-qualified students while making progress to strengthen and tailor doctoral programs in mathematics education to meet the growing demand in the twenty-first century.

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